

CLAIMSWHAT IS CLAIMED IS:

1. A partially single-stranded, dumbbell-shaped, covalently closed deoxyribonucleic acid molecule, containing one or more sequences having the formula:



wherein:

N^1N^2 is selected from the group consisting of GT, GG, GA, AT, and AA; and

N^3N^4 is selected from the group consisting of CT, TT, C deoxycytosine, G deoxyguanosine, A deoxyadenosine, and T deoxythymidine.

2. The deoxyribonucleic acid molecule of claim 1, having a chain length within the range of from about 48 to about 116 nucleotides.

3. The deoxyribonucleic acid molecule of claim 1, wherein the base sequence $N^1N^2CGN^3N^4$ is in the single-stranded stem-loop portion of such deoxyribonucleic acid molecule.

4. The deoxyribonucleic acid molecule of claim 1, comprising the nucleotide sequence of SEQ ID NO: 2.

5. The deoxyribonucleic acid molecule of claim 1, comprising the nucleotide sequence of SEQ ID NO: 3.

6. The deoxyribonucleic acid molecule of claim 1, comprising the nucleotide sequence of SEQ ID NO: 4.

7. The deoxyribonucleic acid molecule of claim 1, comprising the nucleotide sequence of SEQ ID NO: 6.

8. The deoxyribonucleic acid molecule of claim 1, comprising the nucleotide sequence of SEQ ID NO: 7.

9. The deoxyribonucleic acid molecule of claim 1, comprising the nucleotide sequence of SEQ ID NO: 8.

10. The deoxyribonucleic acid molecule of claim 1, comprising the nucleotide sequence of SEQ ID NO: 9.

2025-10-10 10:24:33

11. A partially single-stranded, dumbbell-shaped, covalently closed deoxyribonucleic acid molecule, comprising at least one base sequence AACGTTCTTC GGGGCGTT as in SEQ ID NO: 1.

12. The deoxyribonucleic acid molecule of claim 11, having a chain length within the range of from about 48 to about 116 nucleotides.

13. The deoxyribonucleic acid molecule of claim 11, wherein the base sequence AACGTTCTTC GGGGCGTT is in the single-stranded stem-loop portion of such deoxyribonucleic acid molecule.

14. The deoxyribonucleic acid molecule of claim 11, comprising the nucleotide sequence of SEQ ID NO: 4.

15. The deoxyribonucleic acid molecule of claim 11, comprising the nucleotide sequence of SEQ ID NO: 6.

16. The deoxyribonucleic acid molecule of claim 11, comprising the nucleotide sequence of SEQ ID NO: 7.

17. A partially single-stranded, dumbbell-shaped, covalently closed deoxyribonucleic acid molecule, comprising at least one sequence selected from the group consisting of:

(a) SEQ ID NO: 2;

(b) SEQ ID NO: 3; and

(c) SEQ ID NO: 1.

18. The deoxyribonucleic acid molecule of claim 17, consisting the nucleotide sequence of SEQ ID NO: 2.

19. The deoxyribonucleic acid molecule of claim 17, consisting the nucleotide sequence of SEQ ID NO: 3.

20. The deoxyribonucleic acid molecule of claim 17, consisting the nucleotide sequence of SEQ ID NO: 4.

21. A deoxyribonucleic acid molecule, consisting of a partially single-stranded, dumbbell-shaped, covalently closed chain of deoxyribonucleoside residues, and containing one or more sequences of the base sequence $N^1N^2CGN^3N^4$, whereby N^1N^2 is an element of the GT, GG, GA, AT or AA group, N^3N^4 is an element of the CT or TT group, as well as C deoxycytosine, G deoxyguanosine, A deoxyadenosine and T deoxythymidine, characterized by its sequence being

a) GTTCCTGGAG ACGTTCTTAG GAACGTTCTC CTTGACGTTG GAGAGAAC or

- b) ACCTTCCTTG TACTAACGTT GCCTCAAGGA AGGTTGATCT TCATAACGTT GCCTAGATCA, or
- c) containing a deoxyribonucleic acid sequence of the base sequence AACG TTCTTCGGGG CGTT,
- d) and whereby the deoxyribonucleic acid molecule has a length of 40 to 200 nucleotides.

22. Deoxyribonucleic acid molecules in accordance with claim 21, whereby the base sequence from characteristic c) is contained in the sequence CCTAGGGGTT ACCACCTTCA TTGGAAAACG TTCTTCGGGG CGTTCTTAGG TGGTAACC CCTAGGGGTT ACCACCTTCA TTGGAAAACG TTCTTCGGGG CGTTCTTAGG TGGTAACC.

23. Deoxyribonucleic acid molecules in accordance with claim 21 or 22, whereby the deoxyribonucleic acid molecule has a preferred length of between 48 and 116 nucleotides.

24. Use of deoxyribonucleic acid molecules in accordance with claims 21 to 23 for immunostimulation applications in humans or higher animals.

25. Use of deoxyribonucleic acid molecules in accordance with claim 24, whereby the sequence of the base sequence $N^1N^2CGN^3N^4$ is in the single-stranded area.

26. Use of deoxyribonucleic acid molecules in accordance with claim 24 or 25, whereby stimulation can take place in vitro or in vivo.

27. Use of deoxyribonucleic acid molecules in accordance with one or more of claims 24 to 26 as vaccine adjuvancy in therapeutic or prophylactic applications.

28. Use of deoxyribonucleic acid molecules consisting of a partially single-stranded, dumbbell-shaped, covalently closed chain of deoxyribonucleoside residues, and containing one or more sequences of the base sequence $N^1N^2CGN^3N^4$, whereby N^1N^2 is an element of the GT, GG, GA, AT or AA group, N^3N^4 is an element of the CT or TT group, as well as C deoxycytosine, G deoxyguanosine, A deoxyadenosine and T deoxythymidine, for immunostimulation applications in humans or higher animals.

29. Use of deoxyribonucleic acid molecules in accordance with claim 28, whereby the deoxyribonucleic acid molecule has a preferred length of between 40 and 200 nucleotides.

30. Use of deoxyribonucleic acid molecules in accordance with claim 29, whereby the deoxyribonucleic acid molecule has a preferred length of between 48 and 116 nucleotides.

31. Use of deoxyribonucleic acid molecules in accordance with at least one of Claims 28 to 30, whereby the sequence of the base sequence $N^1N^2CGN^3N^4$ is in the single-stranded area.

32. Use of deoxyribonucleic acid molecules in accordance with at least one of Claims 28 to 31, whereby stimulation can take place in vitro or in vivo.

33. Use of deoxyribonucleic acid molecules in accordance with at least one of Claims 28 to 32 as vaccine adjuvancy in therapeutic or prophylactic applications.

34. Use of deoxyribonucleic acid molecules in accordance with at least one of Claims 28 to 33 for induction of an immune response against antigens which are not activating during MHC-I presentation.

35. Use of deoxyribonucleic acid molecules in accordance with at least one of Claims 28 to 34 for breaking the tolerance against autoantigens.

36. Use of deoxyribonucleic acid molecules in accordance with at least one of Claims 28 to 35 for repolarizing of a type-2 immune response to a type-1 response.

37. Use of deoxyribonucleic acid molecules in accordance with at least one of Claims 28 to 36 containing one or more neutralising CpG motifs ("CpG-N") for blocking stimulation effects of ISS.

38. A deoxyribonucleic acid molecule, consisting of a partially single-stranded, dumbbell-shaped, covalently closed chain of deoxyribonucleoside residues, and containing one or more sequences of the base sequence $N^1N^2CGN^3N^4$, whereby N^1N^2 is an element of the GT, GG, GA, AT or AA group, N^3N^4 is an element of the CT or TT group, as well as C deoxycytosine, G deoxyguanosine, A deoxyadenosine and T deoxythymidine, characterized by its sequence being

- a) GTTCCTGGAG ACGTTCTTAG GAACGTTCTC CTTGACGTTG GAGAGAAC or
- b) ACCTTCCTTG TACTAACGTT GCCTCAAGGA AGGTTGATCT TCATAACGTT GCCTAGATCA, or
- c) containing a deoxyribonucleic acid sequence of the base sequence AACG TTCTTCGGGG CGTT.

39. Deoxyribonucleic acid molecules in accordance with claim 38, whereby the base sequence from characteristic c) is contained in the sequence CCTAGGGGTT ACCACCTTCA TTGGAAAACG TTCTTCGGGG CGTTCTTAGG TGGTAACC CCTAGGGGTT ACCACCTTCA TTGGAAAACG TTCTTCGGGG CGTTCTTAGG TGGTAACC.

40. Deoxyribonucleic acid molecules in accordance with claim 38, whereby the deoxyribonucleic acid molecule has a preferred length of between 40 and 200 nucleotides.

41. Deoxyribonucleic acid molecules in accordance with claim 38 or 39, whereby the deoxyribonucleic acid molecule has a preferred length of between 48 and 116 nucleotides.

42. Deoxyribonucleic acid molecules in accordance with claim 38 to 41, whereby the sequence of the base sequence $N^1N^2CGN^3N^4$ is in the single-stranded area.